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STAFF APPRAISAL REPORT

KOREA

ENVIRONMENTAL TECHNOLOGY DEVELOPMENT PROJECT

NOVEMBER 15, 1993

Country Department I
East Asia and Pacific Regional Office

CURRENCY EQUIVALENTS
(July 1993)

Currency Unit - Korean Won (W)

US$1.00 = W785

WEIGHTS AND MEASURES

Metric System

ABBREVIATIONS

EA	-	Environmental Administration
EFB	-	Education Facilities Bureau
ELPD	-	Education Loan Projects Division
EMB	-	Environmental Management Bureau
GERI	-	Genetic Engineering Research Institute
ICB	-	International Competitive Bidding
KAIST	-	Korea Advanced Institute of Science and Technology
KAITECH	-	Korea Academy of Industrial Technology
KIMM	-	Korea Institute of Machinery and Metals
KORDI	-	Korea Ocean Research and Development Institute
KRISS	-	Korea Research Institute of Standards and Science
KWAIST	-	Kwangju Advanced Institute of Science and Technology
MOE	-	Ministry of Education
MOEN	-	Ministry of Environment
MOHSA	-	Ministry of Health and Social Affairs
MOST	-	Ministry of Science and Technology
NIER	-	National Institute of Environmental Research
O&M	-	Operations and Maintenance
OSROK	-	Office of Supply, Republic of Korea
PCR	-	Project Completion Report
PPAR	-	Project Performance Audit Report
R&D	-	Research and Development
S&T	-	Science and Technology
SERI	-	Systems Engineering Research Institute
SME	-	Small and Medium Enterprise
SOE	-	Statements of Expenditure
TAP	-	Technology Advancement Project

FISCAL YEAR

January 1 - December 31

ACADEMIC YEAR

March - February

KOREA

ENVIRONMENTAL TECHNOLOGY DEVELOPMENT PROJECT

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The report is based on the findings of a preappraisal mission which visited Korea during March 1993 and an appraisal mission consisting of Mr. W.E. Rees (mission leader), and Messrs. S.Z. Sung, V.G. Desa and I. Irvine (consultants), which visited Korea during July 1993. Peer reviewers were Messrs. L. Morrell (EA1IN), N. Corwell (EA1PH) and J. Fritz (ASTEN). The report has been endorsed by Messrs. J. Shivakumar, Chief, EA1PH, and C. Madavo, Director, EA1.

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ENVIRONMENTAL TECHNOLOGY DEVELOPMENT PROJECT

Loan and Project Summary

Borrower	:	Republic of Korea
Beneficiary	:	Not applicable
Amount	:	US$90 million equivalent
Terms	:	Repayable in 15 years including 5 years of grace at the Bank's standard variable interest rate.
Project Description	:	The objective of the project is to strengthen: (a) selected national research institutes to identify and adequately address environmental issues and to undertake environmental R&D activities; and (b) the Ministry of Environment's policy and planning role. The project would include specialized equipment, to be financed by the Bank (baseline cost, US$80.8 million) to assist in strengthening the R&D capacity of eight research institutes and improve MOEN's ability to carry out policy-oriented research. The Government would finance complementary inputs (US$24.4 million) relating to making the equipment operational and monitoring it thereafter, namely, local transportation and installation costs, O&M and consumables. The project would also include overseas training, visiting experts and library materials, (US$10.0 million), and civil works (US$14.3 million).
Benefits and Risks	:	The project would enhance the capacity of selected national research institutes to identify environmental problems and to undertake environmental R&D. This would result in a better understanding of the technological aspects of environmental problems, improved methods of measuring and monitoring key environmental indicators and more environmentally sound production processes. The project would also result in MOEN being strengthened in its policy and planning role which would lead to improved environmental policy formulation and implementation. There are no major risks associated with the project.

Project Costs:

	Local	Foreign	Total
	(US$ million)		
Ministry of Environment	0.6	2.0	2.6
Korea Advanced Institute of Science and Technology	5.5	22.9	28.4
Korea Academy of Industrial Technology	5.8	20.2	26.0
Korea Research Institute of Standards and Science	4.9	10.7	15.6
Korea Ocean Research and Development Institute	2.6	10.0	12.6
Systems Engineering Research Institute	2.5	10.1	12.6
Kwangju Advanced Institute of Science and Technology	3.7	7.7	11.4
Korea Institute of Machinery and Metals	6.8	6.4	13.2
Genetic Engineering Research Institute	1.9	5.2	7.1
Baseline Cost	34.2	95.3	129.5
Contingencies			
Physical	3.4	9.5	12.9
Price increase	5.5	8.1	13.6
Subtotal	8.9	17.6	26.5
Total Project Cost/a	43.1	112.9	156.0

Financing Plan:	Local	Foreign	Total
	(US$ million)		
Government	43.1	22.9	66.0
IBRD	-	90.0	90.0
Total	43.1	112.9	156.0

Estimated Disbursements:

Bank FY	1994	1995	1996	1997	1998
Annual	9.0	17.0	34.0	22.0	8.0
Cumulative	9.0	26.0	60.0	82.0	90.0

/a Does not include duties, taxes and fees estimated at US$7.7 million.

Economic Rate of Return: Not applicable.

Poverty Category: Not applicable.

Map: IBRD No. 25205

KOREA

ENVIRONMENTAL TECHNOLOGY DEVELOPMENT PROJECT

I. ENVIRONMENTAL INSTITUTIONS AND POLICIES

A. Introduction

1.1 Among the consequences of Korea's rapid industrialization has been the increasing degradation of the environment. Air, water and noise pollution are major problems. Waste disposal, in densely populated Korea, is becoming a critical concern.[1/] There is also an increasing concern to develop more efficient methods of production to conserve natural resources and reduce pressures on the environment. The Government has responded to the emerging environmental problems by strengthening the institutional and legal framework so as to address these problems more effectively. In 1990, the existing Environmental Agency was upgraded to the Ministry of Environment and new basic legislation was introduced (para. 1.4). Prosecutions of environmental offenders are being pursued and the principle of "polluter pays" is being enforced.

1.2 Strengthening the Government's institutional and legal framework is an important part of the strategy to address environmental problems. Equally important is the need for improved understanding of the scientific and technical nature of these problems This includes a better understanding of basic scientific relationships as well as improved methods of measuring aspects of environmental degradation and more effective monitoring arrangements. In these areas, the universities are playing an increasingly important role. Research programs in the natural sciences are placing greater emphasis on environmental concerns and teaching programs are increasing their environmental focus. Engineering faculties are placing more emphasis on research and teaching in environmental technology.

1.3 Complementing the work of the universities are the national research institutes. There are about 15 such institutes, mainly under the authority of the Ministry of Science and Technology (MOST). They were established in the 1960s and 1970s to provide public sector leadership in key areas of industrial R&D. However, with large-scale private firms currently accounting for more than 70% of total R&D expenditures in Korea, the research institutes are now focusing on non-commercially oriented applied research and in research support and technical assistance to small and medium enterprises which lack the resources to undertake R&D activities. Among the areas of rising interest to the research institutes is the development of technology to improve environmental measurement and monitoring, environmentally compatible

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1/ Environmental problems, although severe, are showing some improvement in certain areas. For example, the concentration of sulphur dioxide in Seoul decreased from 0.056 ppm to 0.043 ppm between 1985 and 1991, and in Pusan, from 0.047 ppm to 0.038 ppm in the same period. Water quality in the Han River improved by about 9% and in the Nakdong River by 17% during 1985-90. On the other hand, domestic solid waste in Korea increased by 25% during 1987-90 and industrial waste by 52% in the same period.

products, environmentally sound production processes, training of industry personnel in these areas, etc.

B. Institutional and Legal Framework

1.4 From modest beginnings, Korea has developed a sophisticated and comprehensive framework of environmental institutions and legislation. The creation of the Pollution Control Division in the Ministry of Health and Social Affairs (MOHSA) in 1973 was followed by its upgrading (within MOHSA) to the Environmental Management Bureau (EMB) in 1977. The EMB had divisions for environmental planning, air and water quality. This was followed in 1978 by the Environmental Preservation Law, the first major environmental statute in Korea. This law introduced a number of important regulatory devices such as the promulgation of environmental standards, environmental monitoring, environmental impact assessments for new projects, emission standards and control, etc. To strengthen implementation of the law, the EMB was upgraded in 1980 to the Environmental Administration (EA) with the status of an independent agency under MOHSA. Also in 1980, six regional environmental monitoring offices were set up under the EA.

1.5 The increasing complexity of environmental issues and the growing sensitivity to them in the 1980s led the Government to conclude that existing legislation needed to be broadened and its implementation strengthened. This resulted in 1990 in the upgrading of the EA into the cabinet-level Ministry of Environment (MOEN) and, in 1991, in the introduction of new basic legislation (the Basic Environmental Policy Law). This was supported by separate laws dealing with specific problems such as air preservation, water preservation, noise control, hazardous substance control, solid waste management, marine pollution, etc. Enactment of this legislation has given the Government a stronger mandate to address a broad range of environmental issues. The legislation is also subject to periodic review and has already been revised with regard to solid waste and marine pollution, and natural environment preservation.

1.6 The key role in monitoring environmental performance and enforcing the regulations lies with the Ministry of Environment. MOEN also has a policy and planning role which covers the formulation of comprehensive environment plans and policy formulation in respect of air and water quality, waste management, environmental impact assessment and natural resource conservation. MOEN also has overall responsibility for carrying out environmental impact assessments. Technical support is provided by the Engineering and Technology Development Bureau of MOEN (Annex 1). Three technical bureaus are responsible for the management of air quality, water quality and waste management. The bureaus are responsible for implementing quality preservation plans and setting environmental standards. They oversee the work of the six regional environmental offices of MOEN, which are responsible for ongoing monitoring activities, collection and analysis of statistics, oversight of waste processing facilities, etc. The research arm of MOEN is the National Institute of Environmental Research (NIER), whose activities are described in more detail in para. 1.15. Until 1991, NIER was responsible for training environmental personnel, mainly for MOEN's regional offices and for local

authorities. At the end of 1991, NIER's training department was reorganized as a separate Training Institute for Environmental Officials.[2/]

1.7 Under the jurisdiction of MOEN are several other agencies. The Central Environmental Disputes Coordination Commission coordinates investigations into environmental disputes and the assessment of damages carried out by the regional commissions (para 1.8). The Korea Resources Recovery and Reutilization Corporation is responsible for the collection and treatment of recyclable waste, technology to improve such treatment, reutilization of waste products (paper, oil, rubber, etc.) and the operation of a waste products management fund. The Environmental Management Corporation builds and operates industrial waste and garbage treatment facilities and landfills. It also provides technical support for the design and construction of local treatment facilities and helps to finance these facilities through a fund which receives charges made against industry for the discharge of pollutants above permissible levels.

1.8 In June 1992, the Government decided to decentralize a number of monitoring and enforcement responsibilities to the 14 municipal and provincial governments outside Seoul. The latter are now responsible for guidance and inspection of firms, issuance of permits and registration of pollutant-discharging firms, levying and collection of discharge taxes and negligence fines, and closing down repeat offenders. MOEN retains central authority for environmental impact assessments and, through its regional offices, local responsibility for monitoring air, water and soil quality and for the registration of toxic chemical manufacturers. The decentralized activities will be carried out by the municipal/provincial Departments of Environmental Protection, which already exist. However, the latter are being reinforced by over 1,500 new environmental personnel to be allocated to the local authorities. Fourteen local Environmental Disputes Coordination Commissions with membership representing the public and private sectors and environmental groups, adjudicate local environmental matters, including appeals against charges and fines, the enforcement of legislation, etc. The commissions' decisions are binding pending appeals to the Ministry of Justice.

C. Environmental Policies

1.9 The overall thrust of Korea's environmental policies is highlighted in the Seventh Five-Year Plan (1991-96), which devotes an entire chapter to environmental issues. A major objective of the Plan is to raise environmental standards to the level of the advanced industrial countries in three major areas - water quality, solid waste disposal and air quality. The present system of water quality management, which is defined in terms of administrative districts, will be modified to encompass four major river areas subdivided into 11 quality control areas. This will permit water quality to

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2/ The Institute has a staff of 35 which is supplemented by guest lecturers, mainly from the universities. In 1991 environmental training was provided to 3,293 persons from the public and private sectors. Courses covered such topics as analysis, testing and public policy monitoring.

be handled on a functional rather than an administrative basis. Water quality will be raised through doubling the sewerage treatment rate to 65% which will entail the construction of 75 new human waste treatment plants by 1996. Industrial and livestock pollution will be reduced through the construction of 128 and 32 wastewater treatment plants respectively.

1.10 Solid waste disposal capacity will be expanded through the establishment of 38 million m2 of landfill, which will be designed specifically to curb hazardous effects such as groundwater pollution. However, in order to reduce the demand for landfills in a land-scarce country, increasing emphasis will be placed on reuse, recycling and incineration. Reuse is being encouraged through the introduction of advance deposits to ensure that the producers of toxic or nondegradable products (e.g. tires) finance their reuse or disposal.[3/] To increase recycling of domestic solid waste, the recycling campaign for households will be strengthened through the introduction of a waste information system. Incineration facilities will be expanded through the construction of 51 incinerators of 200 tons/day capacity.

1.11 To reduce air pollution, vehicle emissions standards will be rigorously enforced and this will be enhanced by making the use of unleaded gasoline compulsory. The use of liquid natural gas will be expanded beyond Seoul to all major cities and industrial areas by increasing the supply from 2.3 million tons/year (1990) to 6.6 million tons/year by 1996. Oil refineries will be encouraged to expand desulpherization facilities and the sulphur content for light oils will be reduced from 0.4% to 0.2% and for heavier oils from 1.6% to 1% by 1996.

1.12 To reinforce the above measures, a number of other actions will be undertaken. The "polluter pays" principle will be strengthened through the introduction of advanced deposits (para. 1.10) and raising the pollution excise tax on users of environmentally harmful substances. The introduction of the environmental-mark (E-mark) system will encourage firms to produce more environmentally-sound products. The scope and types of projects requiring environmental impact assessments will be increased. A long-term environmental science and technology plan will be developed to ensure that a comprehensive approach is taken to the scientific study of environmental problems and the development of appropriate technology. Finally, Korea is establishing a strong basis for international environmental cooperation through participation in the Montreal Protocol (ozone layer conservation), the Basel Agreement (toxic waste transfer), the Convention on Climate Change and the Biodiversity Treaty. Recently, Korea has also joined its North East Asian neighbors in drafting a wide-ranging plan to combat environmental degradation.

D. Environmental Research

1.13 Overall environmental research priorities are defined within the context of the national Five Year Plan (para 1.9). They are also defined within MOST's long term science and technology (S&T) plan to year 2000 in

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3/ These deposits are paid into a waste products management fund (para 1.7).

which environmental topics form a subset within overall S&T strategies. The core of the S&T plan is the Highly Advanced New Technology Project which focuses on 11 areas of high technology-intensive research and development, with special emphasis on export potential. One priority area is environmental technology development with a strong focus on pollution control technology. These overall plans provide the macro-framework of policies and priorities from which ministries and individual institutions define their own research activities. Several ministries play a key intermediate role in reviewing institutional research programs - the Ministry of Education (MOE) for the universities, MOST for the majority of the national research institutes[4/] and MOEN for NIER. A recent decision has been made to transfer responsibility for the environmental technology part of the Highly Advanced New Technology Project from MOST to MOEN. Within individual institutions, internal procedures for reviewing research priorities and programs may differ somewhat but usually involve a high-level research review committee, reporting to the institution's head, who has the final responsibility for approval. The flow of information through the hierarchy of institutions from national plans to individual institutes is quite effective in Korea and has resulted in the broad range of S&T research efforts being generally relevant to the country's overall development objectives. This has undoubtedly made a substantial contribution to Korea's rapid industrialization.

1.14 Environmental research in Korea is carried out in a broad range of institutions - in university departments of natural science and engineering, in the agricultural and veterinary colleges, in a number of national research institutes and in the major private sector research institutes, and in the Ministry of Environment. While there are no formal demarcation lines between the research activities of the different institutional groups, particular fields of specialization can be discerned. Much basic research in environmental science is done in the university departments of natural science and aims at a better understanding of basic scientific relationships bearing on environmental problems. The departments of engineering have a greater focus on applied science and the development of technology in crucial areas such as pollution control and industrial waste management. The agricultural and veterinary colleges concentrate on a range of research topics relevant to rural environmental problems, such as soil pollution from animal waste. A number of national research institutes, mainly under the jurisdiction of MOST, are expanding their environmental role. Increasing emphasis is being given to the development of pollution control technology, low pollution/ecologically sustainable production processes and improved environmental measurement techniques. Outreach programs to assist small and medium enterprises to address environmental problems are also being expanded by the institutes. The environmental activities of the major private sector research institutes reflect particular industry problems, e.g. reducing automobile exhaust emissions, waste water treatment, etc.

4/ For a description of the role of MOE and MOST in reviewing institutional research programs, see: Staff Appraisal Report, Korea Universities Science and Technology Research Project, IBRD Report No. 8205-KO, April 23, 1990, pp. 3-6.

1.15 The Ministry of Environment has an important, though largely indirect, influence on overall environmental research through its policy formulation role. As new regulations in areas such as air, water and soil pollution, hazardous waste disposal, etc. are introduced and a higher standards of compliance are mandated, new demand is generated in the environmental research community for research into such topics as pollutant transfer phenomena, more accurate measurement of pollutant levels, improved environment-friendly technology, and so on. Complementing MOEN's policy formulation and regulatory roles is the National Institute of Environmental Research. NIER's research priorities are set by MOEN's Executive Committee, chaired by the Vice-Minister, in consultation with other relevant ministries, especially MOST. The latter also finances some of NIER's research programs. NIER has a staff of 184 including 99 researchers supported by 45 technical staff. About 90% of the research staff have graduate degrees. About 60 contract research staff, drawn mainly from the universities, are also employed by NIER. Research staff are employed mainly in the four research departments - air quality, water quality, waste management and environmental health. There are also two specialized laboratories conducting research into automotive emissions and lake water quality. NIER also acts as a national clearing house on environmental information and promotes international cooperation activities.

1.16 The dissemination of environmental research results is enhanced by the strong channels of communication within the environmental research community in Korea. This community is served by some 20 professional associations ranging from the specific, e.g. the Korea Society of Waste Management to the more general, such as the Korea Society of Biotechnology and Bioengineering. These associations are linked at the national level through the Korea Research Council on Environmental Sciences. The Council was established in 1987 to serve as an information exchange among the professional associations but has gained in influence and now serves as a source of advice to the Government on environmental policies. The Council has a formal annual meeting but sponsors more frequent meetings of its topical committees (environmental health, air quality, etc.). There is also a strong tradition within the scientific community to publish research results in international, national and local journals, and environmental scientists and technologists are significant participants. Symposia on environmental topics are held regularly and published proceedings are increasingly available. Dissemination also takes place through individuals participating in cooperative research programs such as the university researchers contracted to work in NIER and in the cooperative research projects involving the universities and the national research institutes. The latter sometimes include researchers from the private sector.

E. Environmental Role of the Project Institutions

1.17 The role of MOEN has been described above in paras. 1.6-1.7. The eight national research institutes, also being assisted under the project, have broad ranging functions within the general field of industrial technology development. But with increasing national priority being given to addressing environmental problems, the institutes are becoming increasingly active in the development of environmental technology and in the provision of environmental

services to industry. The Korea Ocean Research and Development Institute (KORDI) carries out marine environmental impact assessments for energy, industrial and mineral projects with special emphasis on marine pollution and the effect on marine life, especially fisheries. KORDI also monitors coastal pollution and studies its evolution, and carries out sedimentation studies. Measurements and standards relating to chemical analysis of coastal waters and the calibration of oceanographic research equipment are also the responsibility of KORDI. Marine resource surveys and modelling of pollutant and sediment transport, damage assessment, thermal diffusion and morphological changes are also carried out. The main focus of the environmental activities of the Korea Academy of Industrial Technology (KAITECH) lies in the provision of R&D services aimed at improving the environmental performance of industry. R&D efforts are concentrated on improving the performance of waste treatment facilities, especially incinerators, improving measurement technology for pollutant emissions and reducing noise and vibration. Research is also carried out into improving specific technologies such as air filters and into more generalized technologies such as the recovery of waste products suitable for recycling. KAITECH plays an important environmental performance testing and inspection role related to industrial facilities.

1.18 The R&D activities of the Korea Institute of Machinery and Metals (KIMM) focus on the reduction of engine emissions, low vibration/low noise technology, improved incineration of difficult wastes and heat energy conservation technology. KIMM also carries out technology commercialization ventures in coordination with industry. The latter include air pollution prevention facilities and performance test technologies. The Korea Research Institute of Standards and Science (KRISS) is the central authority of the national standards and measurement system and as such plays a crucial role in environmental management. KRISS sets standards for air, water and noise pollution, calibrates measuring instruments and publishes certified reference materials for the guidance of the public and private sectors. The R&D activities of KRISS emphasize improvements in measurement technology including the design of more accurate calibration equipment and the development of chemical tests which serve as the basis for improved standards of air and waste quality. The Genetic Engineering Research Institute (GERI) was established to develop R&D capability in biotechnology and as such carries out important environment-related functions. These include research into microbial strain development for the degradation of pollutants, biodegradation of pesticides by mixed cultivation of bacteria, ethanol production from biomass, biodegradation of wastes, development of microbial insecticides as substitutes for chemical ones and the development of non-toxic biofungicides. GERI maintains close relations with other research institutes and the universities and has established a genetic resource center, including a gene bank, to service these institutions.

1.19 The Systems Engineering Research Institute (SERI) provides national systems engineering and software development capacity in support of a range of industrial fields, meteorology, oceanography, aerospace, etc. An important function is the development of an environmental monitoring capability. This includes improvements in weather forecasting, remote sensing measurements of major air pollutants and image processing of satellite data to determine water quality, especially in the major reservoirs and river systems. The Korea

Advanced Institute of Technology (KAIST) is one of Korea's major teaching and research institutions in science and technology. Within a broad range of research activities, environmental topics are increasing rapidly in importance. Specific environmental research projects which were valued at less than US$0.1 million in 1989 had increased to US$2.6 million in 1991. This represents an increase from less than 1% to about 11% of KAIST's overall research program. The major areas of focus for KAIST's environmental research efforts are noise and vibration control technology, advanced wastewater treatment and solid waste disposal technologies, air pollution control technology, clean industrial technologies, global environmental impact, etc. The Kwangju Advanced Institute of Science and Technology (KWAIST) is being developed as a regional campus of KAIST which will become eventually an autonomous institution. It will have five departments, including a department of environmental science and engineering. The latter will have a strong focus on regional environmental concerns in agriculture and on biotechnology.

F. Bank's Role in Technology Advancement and Education

1.20 The Bank has provided support in several areas of technology development, starting in 1979 with assistance for developing electronics technology. Support has also been given to strengthening technology-related small and medium enterprises and to financing risky technology-intensive R&D projects. More recently, three technology advancement projects have provided assistance for selected national research institutes to strengthen their capacity to carry out research and development activities in key technology-intensive fields. Some of the institutions assisted under these projects will also be supported under the proposed project (KAIST, KRISS, KAITECH and GERI).

1.21 The first Technology Advancement Project (Ln. 3037-KO) focused on strengthening industrial R&D capacity in three national research institutes, mainly in the electrical and mechanical sectors. Special emphasis was placed on improving advice and technical services to SMEs. The project was implemented successfully and closed on schedule. A project completion report (PCR) is currently under preparation. The Second Technology Advancement Project (Ln. 3202-KO) is helping to upgrade R&D capacity in four national research institutes with a focus on biotechnology, energy and natural resource development. The project is assisting also in strengthening the national standards network through upgrading measurement technology and providing technical services to industry. The Third Technology Advancement Project (Ln. 3315-KO) covers three institutes and is helping to strengthen industrial R&D, enhance the development and application of industrial standards and strengt' en joint research activities in basic science. Both ongoing projects are being implemented satisfactorily.

1.22 To complement direct assistance and financial and institutional support for technology development, the Bank has strongly supported the development of science and technical education. Bank lending has been consistent with Korea's needs and priorities in education and has closely paralleled the increasing sophistication of Korean industry. It was recognized that the restructuring of industry towards more skill-intensive, high-technology production would require the continuous expansion and upgrading of technical skills. Thus as industry developed towards greater

skill-intensiveness, Bank assistance to education moved from support for craftsman and technician training through professional engineering education to graduate engineering programs and associated research activities.

1.23 The Bank's initial involvement in the sector under four loans/credits, focused on the development of vocational and technical education at the secondary and post-secondary levels to strengthen the base of the system for producing technical personnel. Project performance audit reports (PPARs) for these projects concluded that they were in general well-conceived and successfully implemented. The reports also concluded that future projects would also benefit from: (a) advanced project preparation before approval; (b) improved local management procedures to expedite approval; and (c) greater focus on policy analysis and evaluation. These lessons were built into the two subsequent operations which were policy-oriented sector loans.

1.24 The first education sector loan (Ln. 1800-KO) concentrated on upgrading junior technical colleges and university colleges of engineering and management through the supply of equipment, staff development and institutional improvements in curriculum development, manpower planning, equipment maintenance and academic accreditation. The PPAR for the loan (Report No. 7252, May 24, 1988) indicates that the major lessons learned were: (a) a stable and responsible sector management agency was the key to successful implementation of the sector program; (b) the sector approach led to a quicker and more sustainable development of institutional capabilities; and (c) the additional time required for preparation was repaid in terms of more efficient implementation.[5/]

1.25 The second education sector loan (Ln. 2427-KO), which incorporated these lessons, assisted in supporting improvements in graduate education in science and engineering, upgrading secondary school and college science programs, expanding graduate research programs, improving sector management and manpower monitoring and strengthening the financial base of private educational institutions. Implementation of the loan was satisfactory and it closed on schedule on June 30, 1989. The PCR for the loan (Report No. 9569, May 17, 1991) concludes that its objectives were largely met. Policy and institutional improvements of particular relevance to science education were introduced in relation to accreditation of colleges of natural science and science education departments, upgrading and expanding staffing of these institutions and the planning of facilities and equipment; at the secondary level, a new experimentation-oriented science curriculum was introduced, a system to monitor student achievement in science developed, new examination and college admission procedures introduced and science teachers upgraded through in-service training.

1.26 In recent projects, the Bank is continuing its emphasis on improving the quality of science and technical education and strengthening

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5/ The Bank's positive role in Korea's education sector under the first five lending operations is documented in the OED report titled Review of the Impact of World Bank Lending for Educational Development in Korea (Report No. 5950; December 4, 1985).

scientific and technological research in the universities. The Science Education and Libraries Computerization Project (Ln. 3468-KO) aims at raising the quality of science education programs in the secondary schools and universities and improving access to information of students, faculty and researchers. Recognition of the importance of the training of craftsmen, which occupy the base of the technical skills pyramid, is found in two vocational education projects (Lns. 3314-KO and 3469-KO) which are improving the quality of vocational education in several hundred vocational high schools. The Universities Science and Technology Research Project (Ln. 3203-KO) is assisting about 50 universities to broaden and deepen their basic research programs in priority fields of science and technology. Implementation of the four projects is proceeding satisfactorily. The increasing priority being given by the Government to addressing environmental issues is being assisted under the recently-approved Environmental Research and Education Project (Ln. 3612-KO). It will assist in improving the capacity of selected agricultural and veterinary colleges to address rural environmental problems through strengthening relevant research programs and environment-related teaching courses.

II. THE PROJECT

A. Origin of the Project

2.1 The Government included the project in its CY93 list of projects suitable for external financing and formally asked the Bank for assistance in November 1992. Most of the preparation work was completed by the Government in accordance with requests for information formulated by the Bank. The project was preappraised in March 1993 and appraised in July 1993.

B. Project Objectives and Rationale

2.2 The objective of the project is to strengthen: (a) selected national research institutes to identify and adequately address environmental issues and to undertake environmental R&D activities; and (b) MOEN's policy and planning role.

2.3 In recent years, Korea has done much to develop environmental policies and to create the institutional and legal framework to implement these policies. Within this framework, there is an important role for R&D activities which address the need for a better technical understanding of environmental problems and to develop the technology that would assist in solving them. With the rapid growth of private sector investment in R&D, the research institutes are changing the focus of their activities and this includes an increasing concern for addressing environmental problems. The project provides the opportunity to assist selected research institutes to

orient their R&D activities increasingly towards environmental concerns.[6/] Visiting experts would work with researchers in the institutes. They would bring state-of-the-art technical knowledge and advice on advanced research techniques. Through seminars, workshops, individual advice, etc. the experts would help local research staff to define key directions for environmental research and to identify related fields of environmental technology development. The link between research and development would be strengthened through these interactions. These institutional improvements would be reinforced by overseas training for local researchers. They would study advanced environmental research techniques in leading institutions and interact with environmental experts. The overall result of these activities would be to strengthen the capacity of the institutes to identify environmental problems and to help in developing appropriate solutions.

2.4 The research institutes are well-staffed with highly qualified researchers but shortages of up-to-date equipment are inhibiting the development of advanced research capabilities. Equipment provided under the project would help to alleviate this problem. Furthermore, project design required an exhaustive analysis of equipment needs in relation to environmental research objectives in the institutes.[7/] This required a review of the institutions' procedures for setting research priorities and identifying the equipment needed to support relevant research programs. These procedures are in general well-established but were strengthened during the review process in respect of new fields of environmental research. The equipment program would include, inter alia, the enhancement of computer systems. This would strengthen the monitoring of environmental variables and enhance environmental research. The project would also provide the opportunity to ensure that MOEN would be in a stronger position to take the lead in formulating environmental policy and play a stronger role in coordinating and monitoring environmental planning activities. By strengthening MOEN's capacity for economic analysis through enhanced computer capacity and overseas training in environmental policy and economics, its ability to assess the economic impact of environmental activities would be improved. Thus project design includes substantial value added in the form of reinforcing the orientation of institutional activities towards environmental problems and strengthening the institutions' capacity to address these problems.

C. Project Design and Description

2.5 The project would include institutional development components in the form of overseas training, visiting experts and library materials together with equipment and equipment-related inputs and civil works to house the

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6/ The project complements the Environmental Research and Education Project (Ln. 3612-KO) which is assisting in strengthening the capacity of selected agricultural and veterinary colleges to address rural environmental problems.

7/ The Project File contains details, for each institution, of major equipment groups in relation to research fields.

equipment. The Bank would finance the baseline foreign exchange cost of 1017 months of overseas training (US$5.1 million), 175 months of visiting experts (US$1.7 million) and library materials (US$2.4 million). Details of the overseas training and visiting expert program are given in Annex 2. Schedules for overseas training and visiting experts have been agreed and are included in the Project File. During negotiations, the Government agreed to implement the overseas training and visiting experts program according to the agreed schedules. Terms of reference for the visiting experts have been reviewed and are satisfactory to the Bank. The Bank would also finance equipment (baseline cost, US$80.8 million) which would be allocated among project institutions as follows: MOEN - US$1.6 million; KAIST -US$19.3 million; KAITECH - US$18.5 million; KRISS - US$9.8 million; KORDI - US$8.7 million; SERI - US$8.8 million; KWAIST - US$6 million; KIMM - US$4.9 million; and GERI - US$3.2 million. Equipment lists are included in the Project File. In order to ensure that the equipment is installed and utilized effectively, the Government would finance complementary inputs (baseline cost, US$24.4 million) which would cover local transportation and installation costs, O&M and consumable materials. The Government would also finance civil works (US$14.3 million) to house the equipment, where required.

2.6 The project would finance 60 months of overseas training (US$0.3 million) for MOEN for periods of 1-6 months. The main focus of training would be on environmental policy and economics, environmental technology information and systems. The training would strengthen MOEN's capacity to carry out policy analysis, improve understanding of the economic basis of policies and strengthen the technical basis on which policies are founded. The project would also finance equipment comprising a mainframe computer with associated peripherals and software, estimated to cost US$1.6 million. The computer would assist in monitoring environmental R&D activities and in providing economic analyses of technology options. This would strengthen the capacity to provide practical policy recommendations related to a broad range of environmental issues. Books, journals and reference materials (US$0.1 million) would also be financed to strengthen MOEN's information base. MOEN's component would be managed by the International Cooperation Officer within the Planning and Budget Office, which also contains specialist accounting and procurement staff to assist in project implementation.

2.7 A program of 360 months of overseas training (US$1.8 million) for periods averaging 6 months would be financed for KAIST. The main focus would be on air and water pollution control, solid waste disposal technology and advanced environmental technology. The project would also finance 30 months of visiting experts (US$0.3 million) in fields identical with the overseas training program. Equipment estimated to cost US$19.3 million would be financed under the project. A major focus of the equipment would be for the development of air and water pollution control technology (US$7.7 million). Equipment would also be allocated to support research into global environmental problems and systems (US$4.4 million), solid waste disposal technology (US$3 million) and engineering applications in advanced environmental technology (US$4.2 million). The project would also finance books, journals and reference materials estimated to cost US$0.9 million. KAIST is a major research and teaching institution and its faculty members are typically engaged in both these activities. KAIST has a faculty of 374, all

of whom have graduate degrees including 80% with doctorates. Project implementation would be the responsibility of the Office of Administration (Annex 3) which would be supported by specialist staff from the Procurement Section and the Finance Section. These arrangements are the same as those currently being utilized satisfactorily for the implementation of the KAIST component of Ln. 3202-KO.

2.8 The project would finance 152 months of overseas training (US$0.8 million) for KAITECH for periods of 1-12 months. Training would focus on environmental problems as they relate to industry with special emphasis on the development of pollution technology. Fields of training would include industrial waste water treatment techniques, contamination control, recycling technology treatment and hazardous waste, emission reduction, etc. The project would also finance 24 months of visiting experts (US$0.2 million) for periods of about one month each to offer specialized advice and conduct seminars in the major fields for which overseas training is being sought. The visiting experts would reinforce the training received overseas. Equipment estimated to cost about US$18.5 million would be allocated among the specialized technology centers (Annex 4). There would be a strong focus on assisting small and medium enterprises. Major needs of research would be: (a) production process technology (US$8.3 million) including waste recycling, industrial waste minimization and industrial pollution reduction; (b) materials technology (US$2.2 million) including the development of improved thermal processes, contamination control and improved waste technology; (c) textile technology (US$1.7 million) for the development of lower pollution production technology; (d) chemical technology (US$1.6 million) for waste water analysis and treatment and recycling of chemical-based products, e.g., plastics; and (e) test and inspection technology (US$4.7 million) for measurement and analysis of air, water and noise pollution in industry. Laboratory facilities (US$0.8 million) to house project-financed equipment would be completed during 1994. KAITECH has a research and engineering staff of 296 supported by 115 junior research staff. About 61% of researchers have graduate degrees including 21% with doctorates. Implementation of the KAITECH component would be managed and coordinated by the Planning and Budgeting Section of the Administration Department, supported by procurement and accounting staff from the Purchasing Section and the Accounting Section. Overall supervision would be provided by the Research and Planning Department. This implementation system was used successfully for KAITECH's component under Loan 3037-KO.

2.9 KRISS is receiving assistance for overseas training and visiting experts estimated at about US$0.8 million per annum from Japan and Germany and this fully meets institutional needs. The project would finance equipment estimated to cost about US$9.8 million to be allocated to three major research areas - environmental measurement and evaluation (US$4 million); development and evaluation of pollution-preventing materials (US$3.8 million); and calibration and evaluation of environment measuring equipment (US$2 million). Laboratory facilities to house project-financed equipment (US$2.7 million) would be completed by the end of 1994. KRISS has a senior research and engineering staff of 207 supported by 51 junior staff. About 73% of staff have graduate degrees including 37% with doctorates. Implementation of the KRISS component would be managed by the Department of Planning and Research

Management (Annex 5) with specialist staff being drawn from the Research Management Section and the Industrial Cooperation Section. The Department of Administration would provide further support if needed.

2.10 The project would finance 100 months of overseas training (US$0.5 million) for KORDI for periods of 1-3 months. Training would cover specific technical subjects such as underwater acoustics, water quality modelling and satellite data processing as well as more general state-of-the-art studies in environmental toxicology, chemical ecology, organic pollution, etc. The project would also finance 50 months of visiting experts (US$0.5 million) for periods of 1-2 months to offer specialized advice and conduct seminars in a number of fields including marine environment, coastal dynamics, physical oceanography, ocean ecosystem dynamics, etc. Library materials, estimated to cost US$0.1 million would also be financed under the project. Equipment estimated to cost about US$8.7 million would be allocated among the six research divisions (Annex 6) (US$5.1 million) and for common use (US$3.6 million). The latter, which would include a mainframe computer, would support the ocean data and computer service, ocean instrumentation and audio-visual systems. KORDI is well staffed with highly qualified researchers. There are 143 senior research staff supported by a junior research staff of 121. About 51% of researchers have graduate degrees, including 32% with doctorates. KORDI's component would be implemented by a project manager designated from the staff of the Planning Division, whose director would provide overall supervision. The project manager would be assisted by accounting and procurement staff from the Administrative Division. Staff resources are adequate for the successful implementation of the project.

2.11 The project would finance 160 months of overseas training for SERI (US$0.8 million) for periods of 1-12 months. The major focus of training would be on modelling for environmental climate change and weather prediction. Training would also be provided in data base development for environmental information and statistical methodology related to climate change. Twenty months of visiting experts (US$0.2 million) would also be financed under the project focussing mainly on computer applications for environmental change, air pollution monitoring and remote sensing. The project would finance equipment estimated to cost US$8.8 million. It would be allocated to: (a) the Application Software Division (Annex 7) (US$3.5 million) to develop techniques and software for monitoring climate change, construct models for predicting climate and biosphere changes, etc.; (b) Supercomputer Center (US$3 million) for the construction of a network of realtime environmental science information; (c) Science and Technology Information Systems Division (US$1.4 million) to create numerical and image data bases of environmental technology; (d) Production Management and Automation Research Laboratory (US$0.7 million) to develop techniques to reduce industrial waste and pollution,and to improve measurement of pollution; and the Artificial Intelligence Division, (US$0.2 million) to develop environmental monitoring and image processing techniques. SERI has a senior research staff of 117 supported by 95 junior researchers. About 65% of research staff have graduate degrees including 10% with doctorates. Research staff are supported by 107 technical assistants. Project implementation would be the responsibility of the International Cooperation Section assisted by procurement and accounting staff from the

Finance Section. Staff resources are adequate for the successful implementation of the project.

2.12 The first phase of the new campus for KWAIST will be completed by the end of 1995 and include research facilities for all the graduate schools. In line with this, faculty is planned to expand rapidly from 15 in 1994 to 54 in 1995 and 69 in 1996. To strengthen faculty development, the project would finance 45 months of overseas training (US$0.2 million) for periods of three months and 21 months of visiting experts (US$0.2 million), mainly in the fields of environmental ecology and preservation, and industrial safety. The project would finance equipment estimated to cost US$6 million to be located in the Department of Environmental Science and Engineering (Annex 8). The equipment would be focused mainly in the areas of air, water, soil and marine pollution (US$3.9 million), environmental health and ecosystems (US$1.3 million), and noise and vibration control (US$0.8 million). Laboratory facilities estimated to cost US$2.9 million are being constructed to house the project-financed equipment and they will be completed by the end of 1994. Books, journals and reference materials (US$0.6 million) would be financed to support the development of the institution's library services. Project implementation would be the responsibility of the Office of Academic Affairs which would be supported by specialist accounting and procurement staff of the Office of Planning.

2.13 The project would finance equipment estimated to cost US$4.9 million for KIMM. The equipment would be allocated to: (a) the Mechanical Engineering Research Department (Annex 9) (US$2.3 million) where there would be strong focus on pollutant gas analysis; (b) the Automation Engineering Research Department (US$1 million) where emphasis would be placed on noise and vibration measurement and monitoring in engines; (c) the Test and Evaluation Technology Department (US$0.6 million) for research into analysis of heavy metals in gas and liquids and related element analysis; (d) the Mechanical Systems Research Department (US$0.8 million) where the main focus would be an analysis of combustion products and development of pollution control equipment; and (e) the Technical Information Division (US$0.2 million) which supplies common services in data gathering and processing, and design and programming of environmental information. Laboratory facilities to house project-related equipment (US$7 million) would be completed during 1995. KIMM has a senior research staff of 155 supported by 121 junior research staff. About 62% of staff have graduate degrees including 22% with doctorates. KIMM would finance its training needs from its own resources. KIMM's component would be implemented by a project manager, to be designated among the staff of the R&D Management Division, and assisted by accounting and procurement personnel from the Administrative Division. Staffing is adequate to carry out these tasks.

2.14 The project would finance 140 months of overseas training (US$0.7 million) for GERI for periods of 1-4 months. Training would focus on areas of biodiversity, taxonomy, environmental biotechnology, R&D management, etc. The project would also finance 30 months of visiting experts (US$0.3 million) for periods of 1-2 months, mainly in the same areas for which training is being provided. Expertise in some additional areas would also be sought, e.g. biosafety and monitoring. Equipment estimated to cost US$3.2 million would be

procured to support the strengthening of environmental analysis in biotechnology in the Division of Applied Biology and Process Technology, and the Genetic Resources Center (Annex 10) (US$2 million). The remaining equipment (US$0.4 million) would be allocated to the Pilot Plant Center for pilot processing of environmentally hazardous materials. The International Information Center for Environmental Biotechnology would receive equipment to strengthen its information processing capacity (US$0.8 million) together with books and journals (US$0.7 million). Laboratory facilities to house the project-financed equipment (US$1 million) would be completed during 1995. GERI has a senior research staff of 75 supported by 73 junior researchers. About 99% of staff have graduate degrees including 50% with doctorates. Project implementation would be the responsibility of the Department of Management Planning which will designate a project manager. Support personnel in procurement and accounting will be provided by the Department of General Administration. Adequate staffing is available for the successful implementation of the project.

2.15 During project design, special attention was given to reviewing the procedures by which the participating research institutes identify their research priorities and programs, and draw up related equipment lists. With minor variations, the institutes follow common procedures. Typically, research projects are proposed within the research divisions and the projects reviewed by the division director. Projects passing this scrutiny are sent to a research review committee which is usually chaired by a vice-president and comprises the heads of the major research departments. This committee makes recommendations to the president, who has final approval authority. Equipment requirements are included in proposals for research projects. Projects which successfully pass the review process are then scrutinized by an equipment procurement committee, comprising senior researchers, to ensure that equipment requests are relevant to the research being proposed. Consolidated equipment lists are approved by the president. The institutional research priority framework, within which the above activities take place, is defined with reference to the Government's statements of priority as set out in the national five-year plans and in sectoral plans.

III. PROJECT COSTS, FINANCING AND IMPLEMENTATION

A. Costs

3.1 The total cost of the project is estimated at US$156 million equivalent, net of duties and taxes, consisting of US$112.9 million foreign expenditures and US$43.1 local expenditures. The estimated cost by project component is summarized in Table 3.1 and by category of expenditure in Table 3.2. Detailed costs by component and category are given in Annex 11 and project expenditure by year and recipient in Annex 12.

3.2 Base costs are estimated at July 1993 prices. Equipment costs are estimated on the basis of master lists already drawn up and recent catalogue prices. Civil works costs were provided by the Government and are based on contract awards for similar facilities in Korea. Transportation and installation costs, the initial supply of consumables and the costs of

operations and maintenance are based on recent experience in project institutions. Cost estimates for overseas training, visiting experts and library materials are similarly based on local experience. Duties and taxes, allowing for exemptions, are estimated at US$7.7 million.

3.3 The contingency allowance of US$26.5 million (about 21% of baseline costs) includes contingencies for unforeseen physical conditions and for estimated price increases. Physical contingencies were estimated at 10% of baseline costs for training, visiting experts, library materials, equipment, transportation and installation of equipment, consumable materials, O&M expenditures and civil works. Price increase contingencies were calculated for both local and foreign costs in accordance with the following expected annual average price increase percentages: foreign cost, 2.8% in FY94 and thereafter and local cost, 4.5% in FY94 and 4% thereafter. Accordingly, aggregated price increases are estimated at about 10% of baseline costs plus physical contingencies.

Table 3.1: SUMMARY OF PROJECT COSTS BY COMPONENT

	Won Billion			US$ Million			Foreign as % of total
	Local	Foreign	Total	Local	Foreign	Total	
Ministry of Environment	0.4	1.6	2.0	0.6	2.0	2.6	77
Korea Advanced Institute of Science and Technology	4.3	17.8	22.1	5.5	22.9	28.4	80
Korea Academy of Industrial Technology	4.5	15.8	20.3	5.8	20.2	26.0	78
Korea Research Institute of Standards and Science	3.9	8.4	12.3	4.9	10.7	15.6	68
Korea Ocean Research and Development Institute	2.0	7.8	9.8	2.6	10.0	12.6	79
Systems Engineering Research Institute	2.0	7.8	9.8	2.5	10.1	12.6	79
Kwangju Advanced Institute of Science and Technology	2.9	6.0	8.9	3.7	7.7	11.4	68
Korea Institute of Machinery and Metals	5.3	5.0	10.3	6.8	6.4	13.2	48
Genetic Engineering Research Institute	1.5	4.0	5.5	1.9	5.2	7.1	74
Baseline cost	26.8	74.2	101.0	34.2	95.3	129.5	73
Contingencies							
Physical	2.7	7.4	10.1	3.4	9.5	12.9	73
Price increases	4.3	6.4	10.7	5.5	8.1	13.6	60
Subtotal	7.0	13.8	20.8	8.9	17.6	25.6	66
Total Project Cost /a	33.8	88.0	121.8	43.1	112.9	156.0	72

/a Does not include duties, taxes and fees estimated at US$7.7 million.

3.4 The foreign exchange component of US$112.9 million (about 72% of total estimated project costs) has been calculated on the basis of the following foreign exchange percentages: equipment - 100%, overseas training -90%, visiting experts - 80%, library materials - 100%, transportation and installation - 10%, consumables - 10%, O&M - 10% and civil works - 20%.

Table 3.2: SUMMARY OF PROJECT COSTS BY CATEGORY OF EXPENDITURE

	Won Billion			US$ Million			Foreign as % of total
	Local	Foreign	Total	Local	Foreign	Total	
Equipment	0.0	63.4	63.4	0.0	80.8	80.8	100
Equipment transportation and Installation	3.3	0.4	3.7	4.3	0.5	4.8	10
Operations and Maintenance	6.9	0.7	7.6	8.8	1.0	9.8	10
Consumable materials	6.9	0.7	7.6	8.8	1.0	9.8	10
Overseas training	0.4	3.7	4.1	0.5	5.1	5.6	90
Library materials	0.0	1.9	1.9	0.0	2.4	2.4	100
Visiting experts	0.3	1.1	1.4	0.3	1.7	2.0	80
Civil works	9.0	2.3	11.3	11.5	2.8	14.3	20
Baseline cost	26.8	74.2	101.0	34.2	95.3	129.5	73
Contingencies							
Physical	2.7	7.4	10.1	3.4	9.5	12.9	73
Price increase	4.3	6.4	10.7	5.5	8.1	13.6	60
Subtotal	7.0	13.8	20.8	8.9	17.6	26.5	66
Total project cost	33.8	88.0	121.8	43.1	112.9	156.0	72

B. Financing

3.5 The proposed loan of US$90 million equivalent would finance about 80% of the estimated foreign exchange cost of the project or about 58% of total project costs, net of duties and taxes. The Government would be responsible for the remaining 42% or US$66 million equivalent. The loan amount is limited to US$90 million by the foreign borrowing program and is therefore less than the foreign exchange cost of the project. The loan would finance 100% of the baseline cost of equipment and library materials, 90% for overseas training and 80% for visiting experts. All contingencies would be financed by the government. The loan amount would be allocated as follows:

MOEN (US$2 million), KAIST (US$22.3 million), KAITECH (US$19.5 million), KRISS (US$9.8 million), KORDI (US$9.8 million), SERI (US$9.8 million), KWAIST (US$7 million), KIMM (US$4.9 million), and GERI (US$4.9 million).

Table 3.3: FINANCING PLAN

Category of Expenditure	Government	IBRD	Total
	US$ million		
Equipment	-	80.8	80.8
Equipment transportation and installation	4.8	-	4.8
Operations and maintenance	9.8	-	9.8
Consumable materials	9.8	-	9.8
Overseas training	0.5	5.1	5.6
Library materials	-	2.4	2.4
Visiting experts	0.3	1.7	2.0
Civil works	14.3	-	14.3
Contingencies	26.5	-	26.5
Total	66.0	90.0	156.0

Recurrent Expenditures

3.6 When fully operational, the project would generate recurrent costs for equipment-related consumable materials and O&M estimated at US$6.3 million p.a. in the eight participating research institutes. This represents about 2% of the estimated combined recurrent budgets of the institutes for FY94. These additional expenditures could be accommodated by the institutions without difficulty. Similar recurrent costs would be generated within MOEN but would amount to only about US$0.2 million and therefore would be easily accommodated.

C. Project Management and Implementation

3.7 Responsibility for project implementation in the eight research institutes would lie with each institution. The institutions are adequately staffed with experienced personnel to handle project administration, planning, procurement and reporting. The parent ministries of the project institutions - the Ministry of Trade, Industry and Energy for KAITECH and MOST for the remaining institutions - would not be involved in routine implementation activities but would play an overall coordinating role. The ministries would be informed of general progress in implementation by the project institutions but would become directly involved only in project-wide issues, such as any

proposed amendment to the loan agreement. The ministries would also serve as the link between the institutes and the Ministry of Environment for guidance on environmental policy and operational issues in relation to environmental technology development. MOEN's component would be managed by the Planning and Budget Office, which is suitably staffed for the task (para 2.6). The project implementation schedule is shown in Annex 13. The project would be implemented over a period of four years.

3.8 The bulk of the work in equipment procurement would be undertaken by OSROK, which is highly experienced in procuring equipment under the Bank's international competitive bidding (ICB) procedures. On the basis of equipment lists and specifications provided by the project institutions, OSROK would prepare bidding documents, invite bids, evaluate them in conjunction with the institutions and make contract awards with their agreement. The project institutions would be responsible for installation, initial testing and operation of the equipment, unless specified in the equipment contract that the supplier would perform these tasks. The institutions would also be responsible for maintenance and repair of the equipment including acquisition of spare parts, accessories and consumables, beyond the items and services initially supplied under the contract. Overseas training, the contracting of overseas experts and the procurement of library materials and civil works would be undertaken by the individual institutions. The Bank would supervise the project twice yearly around March and September coinciding as far as possible with the preparation of the semi-annual progress reports (para. 3.14). Overall implementation issues would be handled by the task manager, assisted by a procurement specialist; technical aspects would be the responsibility of a consultant in environmental science. Project supervision would carefully monitor the overall scope of environmental research activities in the project institutions and pay particular attention to the contribution of visiting experts and overseas training in enhancing environmental research. The utilization of project-financed equipment for environmental research would also be monitored. Relevant information necessary for the monitoring activities would be included in the semi-annual progress reports. A supervision plan is given in Annex 14.

Status of Project Preparation

3.9 The advanced stage of project preparation would allow implementation to commence immediately after loan signing. Project institutions have been identified and equipment lists and detailed specifications prepared. The program for overseas training and visiting experts has been reviewed and is satisfactory. Project management authorities have been identified and competent staff are available to handle implementation activities.

Procurement

3.10 Procurement arrangements are shown in Table 3.4. About 85% of the equipment would be procured on the basis of international competitive bidding (ICB) procedures in accordance with the Bank's guidelines. Equipment items in contracts valued at less than US$300,000 may be procured up to an aggregate limit of US$9.6 million through local competitive bidding procedures or, for

contracts below US$50,000, through shopping procedures (aggregate limit US$4.8 million) allowing for the comparison of quotations from at least three eligible suppliers. Local equipment manufacturers would be extended a 15% preference margin, or the prevailing customs duties, whichever is the lower, on bid evaluation under ICB. Local transportation, operations and maintenance costs on equipment, would be financed by the Government under local procedures. Installation costs and costs of consumables, if not included in the equipment contracts, would also be financed by the Government under local procedures. Civil works, to be financed by the Government, would be procured through local competitive procedures acceptable to the Bank. Fellowships for overseas training would be awarded on the basis of local Government procedures acceptable to the Bank. Visiting experts would be selected in accordance with Bank Guidelines for the Use of Consultants. Library materials would be procured on the basis of direct purchase after negotiating for discounts with publishers or their authorized distributors.

3.11 In accordance with successful practices for procurement under ICB used in recent education and technology advancement projects in Korea, OSROK, with one exception, would not be required to refer equipment contracts to the Bank for prior review before making contract awards.[8/] However, complete bidding documents including commercial terms, schedules of requirements and technical specifications would be sent to the Bank before each invitation to bid. Bid evaluation reports, documents and contracts would be retained by OSROK for ex-post review by Bank missions. The exception applies to contracts for mainframe computers, estimated to cost US$900,000 or more, to be procured by three project institutions. In this case, draft bidding documents, including specifications and bid evaluation reports, would be submitted for prior review by the Bank before inviting bids and awarding contracts respectively. This is necessary because of the complexity and sensitivity of procuring mainframe computers under ICB procedures. During negotiations, the Government agreed to submit to the Bank, the bidding-related documents mentioned above.

Disbursements

3.12 The proposed loan of US$90 million would be disbursed over a period of 4.5 years (Annex 15). This is less than the standard disbursement profile for education projects in Korea, which is 5.5 years. However, it is in line with disbursement periods for previous technology advancement projects assisting national research institutes, some of which are included in the proposed project. The completion date of the project would be March 31, 1998 and the closing date September 30, 1998. Disbursements would be made on the basis of (a) 100% of foreign expenditures for imported equipment or, 100% of local expenditures (ex-factory cost) for locally manufactured equipment; (b) 65% of local expenditures for other equipment items procured locally; and (c) 100% of foreign expenditures on overseas training, visiting experts and library materials. Reimbursement for technical assistance expenditures and for each equipment contract of US$300,000 equivalent or more, would be fully documented. Reimbursement for expenditures on library materials and for each

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8/ OSROK has had long experience in procuring equipment under the Bank's ICB procedures. It is well-staffed with competent personnel. OSROK's record in the implementation of ongoing education and technology advancement projects has been exemplary.

equipment contract of less than US$300,000, would be made against statements of expenditure (SOE) for which full supporting documentation would be retained in the project institutions, for review as requested, by visiting Bank missions. Administrative and accounting capability in the institutions is adequate to support the SOE procedure.

Table 3.4: SUMMARY OF PROPOSED PROCUREMENT ARRANGEMENTS

Category of expenditure	Procurement Method				Total cost including contingencies
	ICB	LCB	Other a/	NBF	
	(US$ million)				
Equipment	81.5	9.6	4.8	-	95.9
	(68.7)	(8.1)	(4.0)		(80.8)
Equipment transportation and installation	-	-	-	6.0	6.0
				(0.0)	(0.0)
Operations and maintenance	-	-	-	12.6	12.6
				(0.0)	(0.0)
Consumable materials	-	-	-	12.6	12.6
				(0.0)	(0.0)
Overseas training	-	-	6.5	-	6.5
			(5.1)	-	(5.1)
Library materials	-	-	2.8	-	2.8
			(2.4)	-	(2.4)
Visiting experts	-	-	2.4	-	2.4
			(1.7)		(1.7)
Civil works	-	-	-	17.2	17.2
		-		(0.0)	(0.0)
Total	81.5	9.6	16.5	48.4	156.0
	(68.7)	(8.1)	(13.2)	(0.0)	(90.0)

Note: Figures in parentheses are the respective amounts to be financed by the Bank loan.
NBF: Not Bank-financed.
a/ Includes international and local shopping, selection of fellows using existing Government procedures acceptable to the Bank, selection of visiting experts following Bank guidelines for consultants, and direct purchase.

3.13 To facilitate disbursements, a special account, maintained in US dollars, would be set up at the Korea Exchange Bank to cover the estimated average amount required to finance project expenditures for the next four months. There would be nine subaccounts with amounts allocated as follows: MOEN (US$0.2 million); KAIST (US$2.2 million); KAITECH (US$1.9 million); KRISS (U$1.0 million); KORDI (US$1.0 million); SERI (US$1.0 million); KWAIST (US$0.7 million); KIMM (US$0.5 million); and GERI (US$0.5 million). Applications for

replenishment of the special account would be submitted to the Bank on a monthly basis or whenever the amount requested exceeds one-third of the initial deposit whichever comes first.

Accounts, Audit and Reporting

3.14 The Government would cause the project institutions to maintain project accounts in accordance with sound accounting practices. During negotiations, the Government gave assurances that audited accounts, including the special account and SOE would be sent to the Bank within six months of the end of the financial year. Audit reports would include a separate opinion for expenditures under SOE procedures. The Government would cause each project institution to submit semi-annual progress reports to the Bank in March and September and provide status reports for visiting missions. Within six months of the closing date, each project institution would submit Part II of the Project Completion Report.

D. Environmental Impact

3.15 The project will not have any negative impact on the environment. The equipment to be supplied under the project would be located in properly designed laboratories which operate under standard environmental and safety procedures. The positive environmental aspects of the project are summarized in the following paragraph on project benefits.

IV. BENEFITS AND RISKS

A. Benefits

4.1 The project would strengthen the capacity of selected national research institutes to identify and address environmental issues and to undertake environmental R&D. This would result in a better understanding of the technological aspects of environmental problems, improved methods of measuring and monitoring key environmental indicators and more environmentally-sound production processes. The project would also result in MOEN being strengthened in its policy and planning role which would lead to improved environmental policy formulation and implementation.

B. Risks

4.2 There are no major risks associated with the project.

V. AGREEMENTS REACHED AND RECOMMENDATION

5.1 The Government has agreed that:

(a) the program of overseas training and visiting experts would be implemented according to agreed schedules (para 2.5);

(b) with respect to contracts for mainframe computers estimated to cost US$900,000 or more, draft bidding documents including specifications and bid evaluation reports, would be submitted for prior review by the Bank before inviting bids and awarding contracts respectively (para. 3.11);

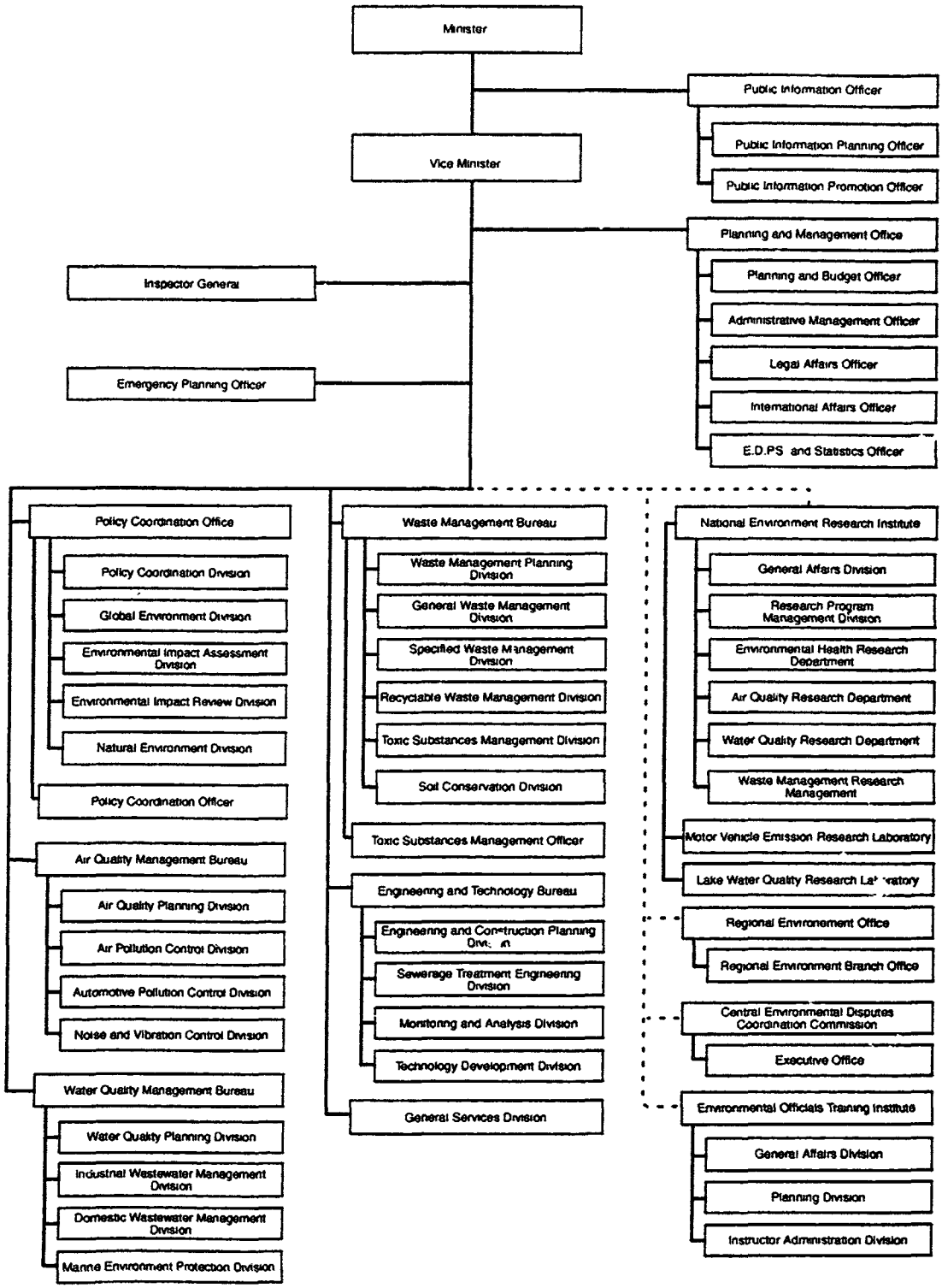
(c) audit reports would be submitted by the Government to the Bank within six months of the end of each financial year (para. 3.14);

(d) progress reports would be submitted by each project institution semi-annually in March and September of each year (para. 3.14); and

(e) within six months of the closing date, Part II of the project completion report for each project institution would be submitted to the Bank (para. 3.14).

5.2 Subject to the above conditions, the project constitutes a suitable basis for a Bank loan of US$90 million equivalent to the Republic of Korea for a term of 15 years, including 5 years of grace at the Bank's standard variable interest rate.

KOREA
ENVIRONMENTAL TECHNOLOGY DEVELOPMENT PROJECT
Ministry of Environment
Organization Chart



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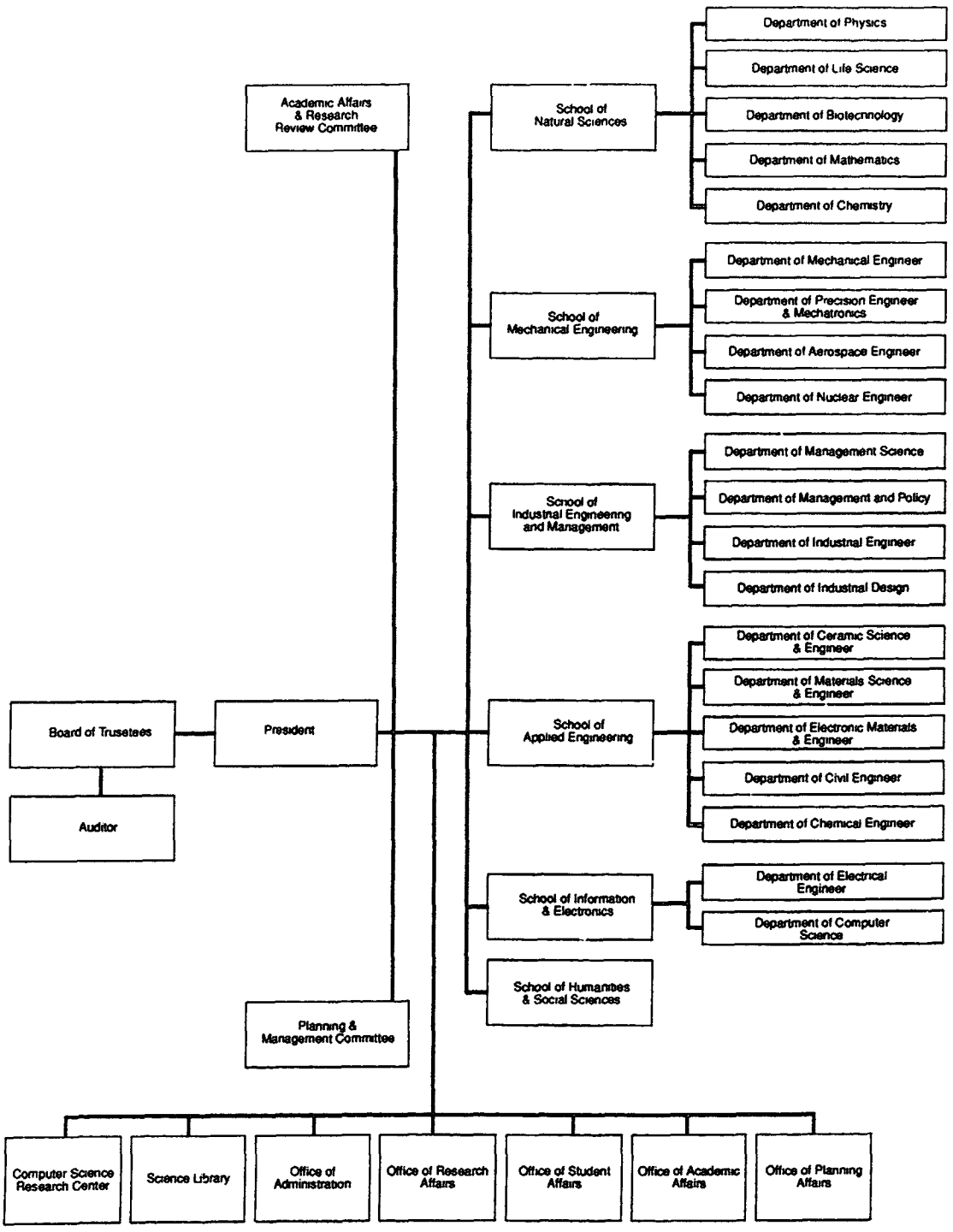
KOREA

ENVIRONMENTAL TECHNOLOGY DEVELOPMENT PROJECT

Summary of Overseas Training and Visiting Experts

	Overseas Training		Visiting Experts	
	Total trainees	Total staff-months	Total experts	Total staff-months
Ministry of Environment	21	60	-	-
Korea Advanced Institute of Science and Technology	60	360	17	30
Korea Academy of Industrial Technology	48	152	32	24
Korea Research Institute of Standards and Science	-	-	-	-
Korea Ocean Research and Development Institute	71	100	32	50
Systems Engineering Research Institute	30	160	15	20
Kwangju Advanced Institute of Science and Technology	15	45	9	21
Korea Institute of Machinery and Metals	-	-	-	-
Genetic Engineering Research Institute	72	140	43	30
Total	317	1017	148	175

KOREA
ENVIRONMENTAL TECHNOLOGY DEVELOPMENT PROJECT
Korea Advanced Institute of Science and Technology
Organization Chart



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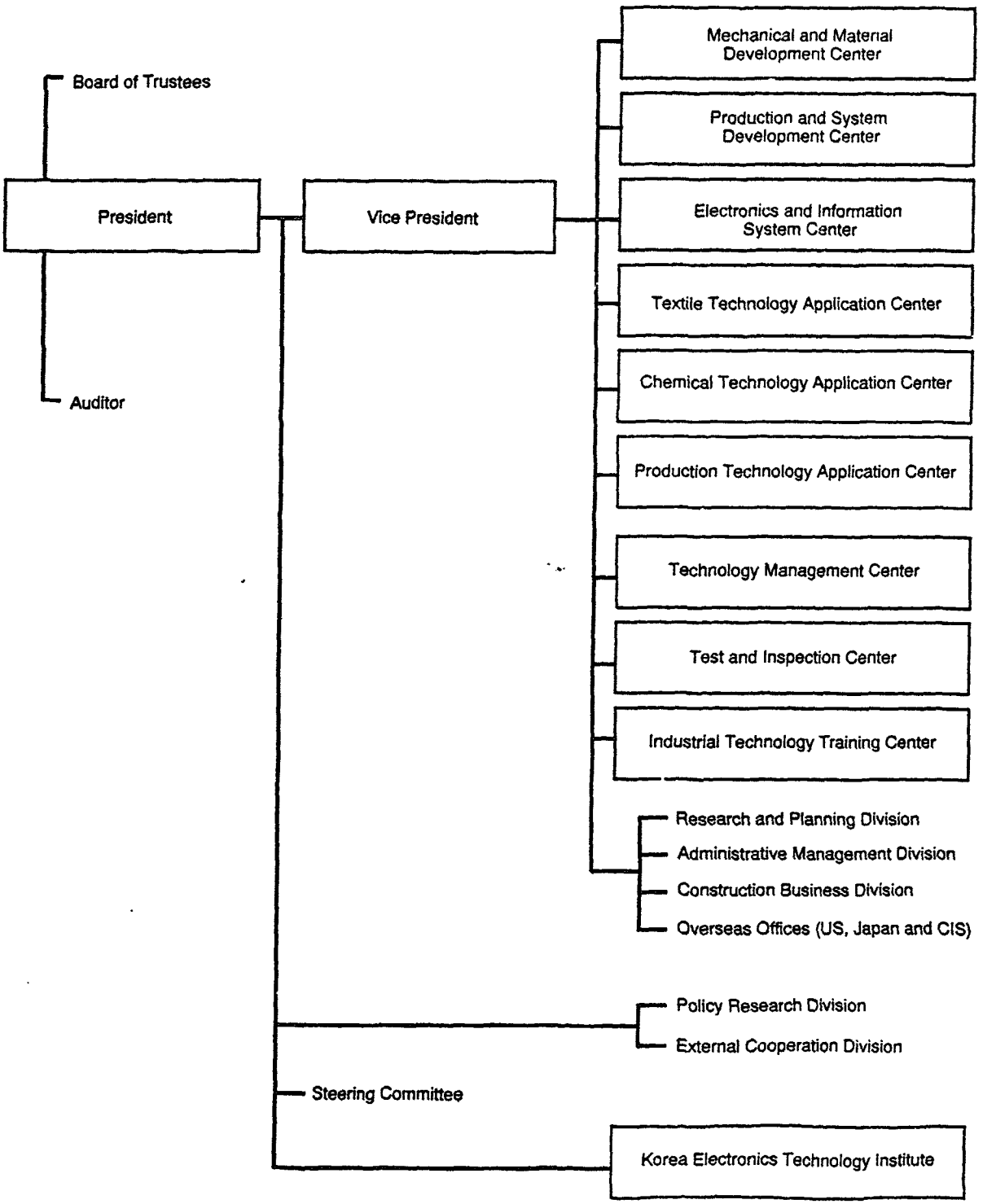
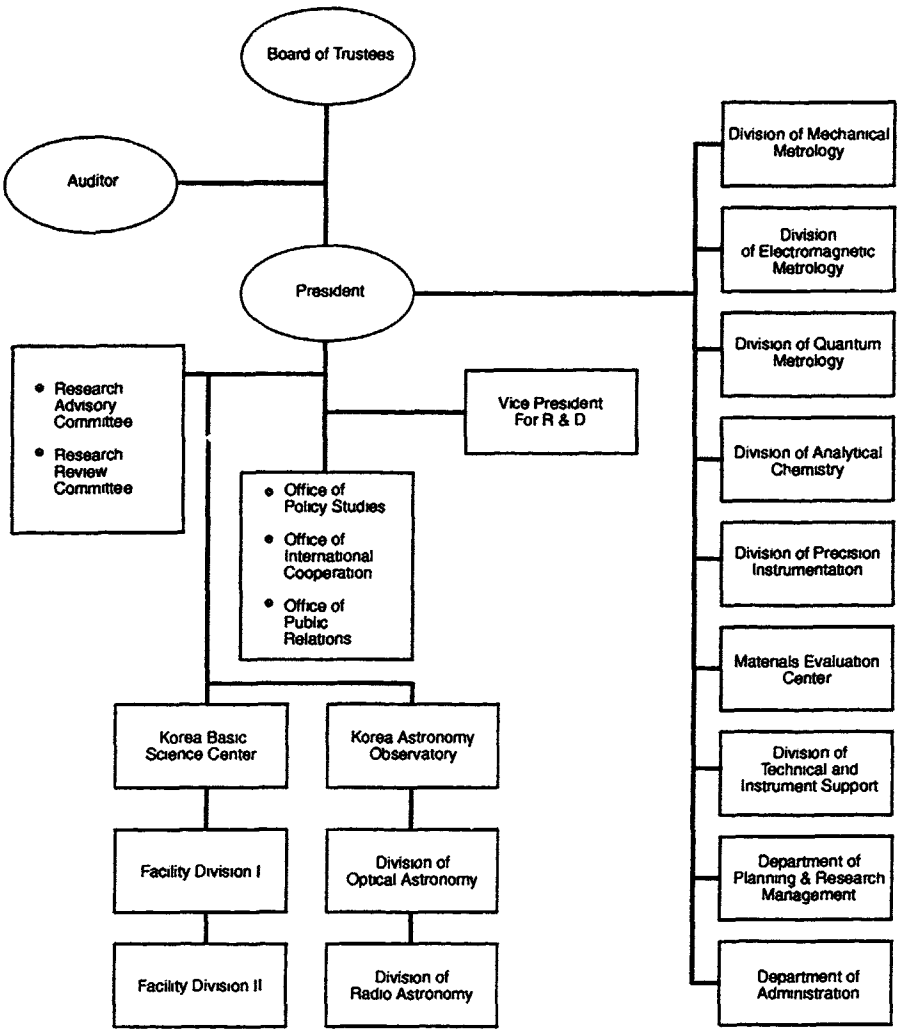
KOREA
ENVIRONMENTAL TECHNOLOGY DEVELOPMENT PROJECT
Korea Academy of Industrial Technology
Organization Chart



KOREA
ENVIRONMENTAL TECHNOLOGY DEVELOPMENT PROJECT
Korea Research Institute of Standards and Science
Organization Chart



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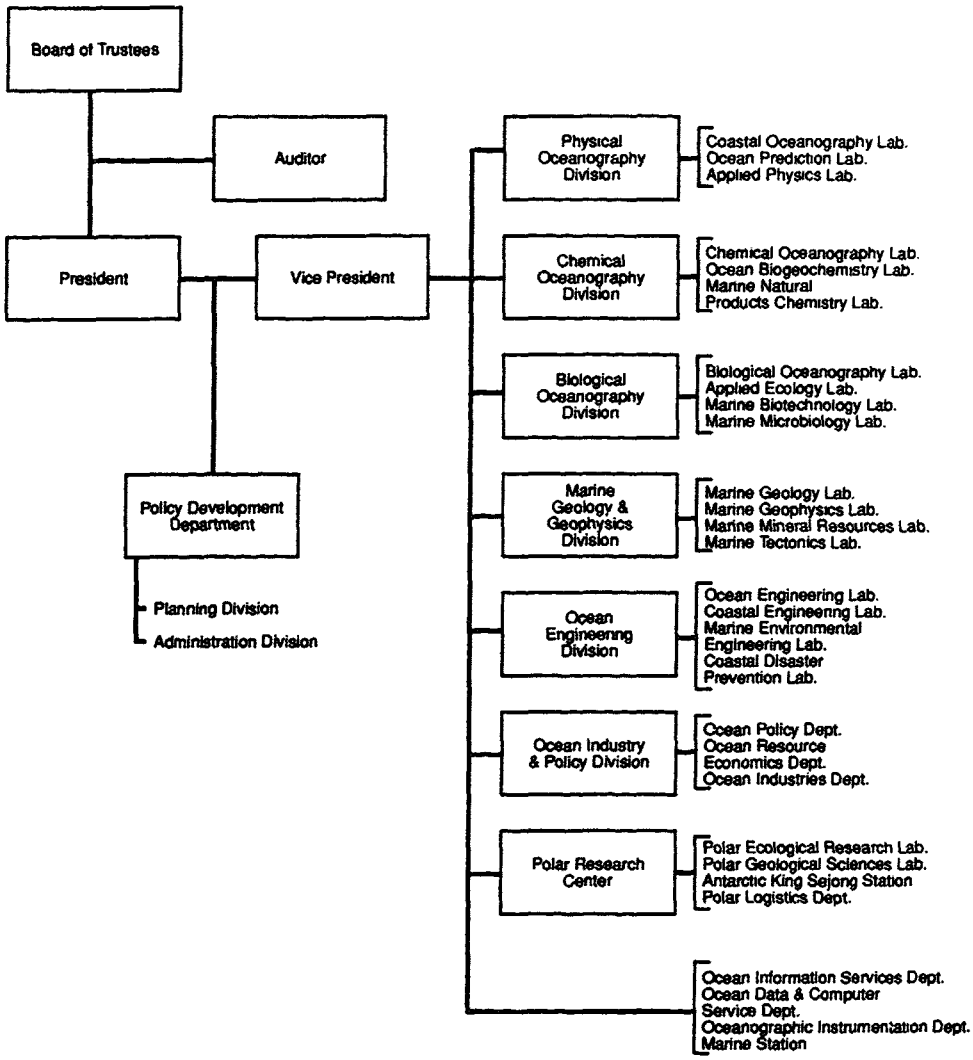
KOREA
ENVIRONMENTAL TECHNOLOGY DEVELOPMENT PROJECT
Korea Ocean Research and Development Institute
Organization Chart



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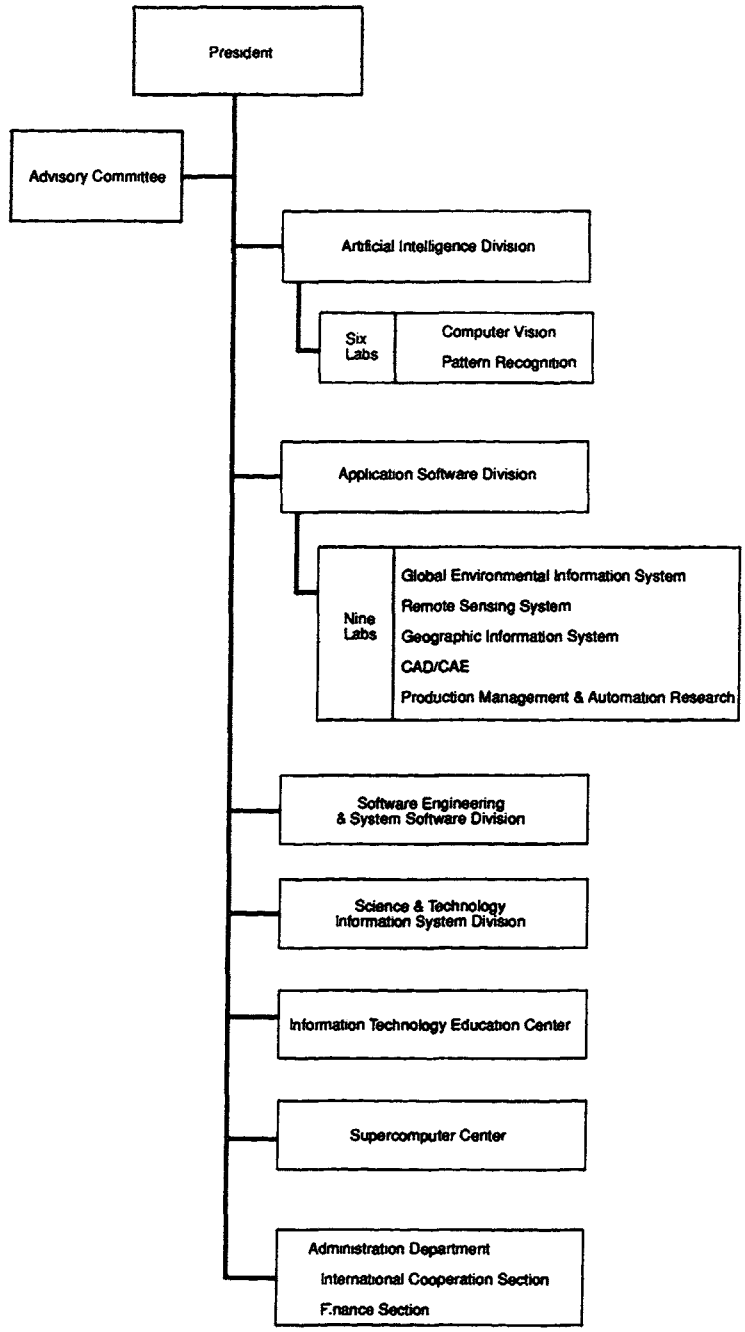
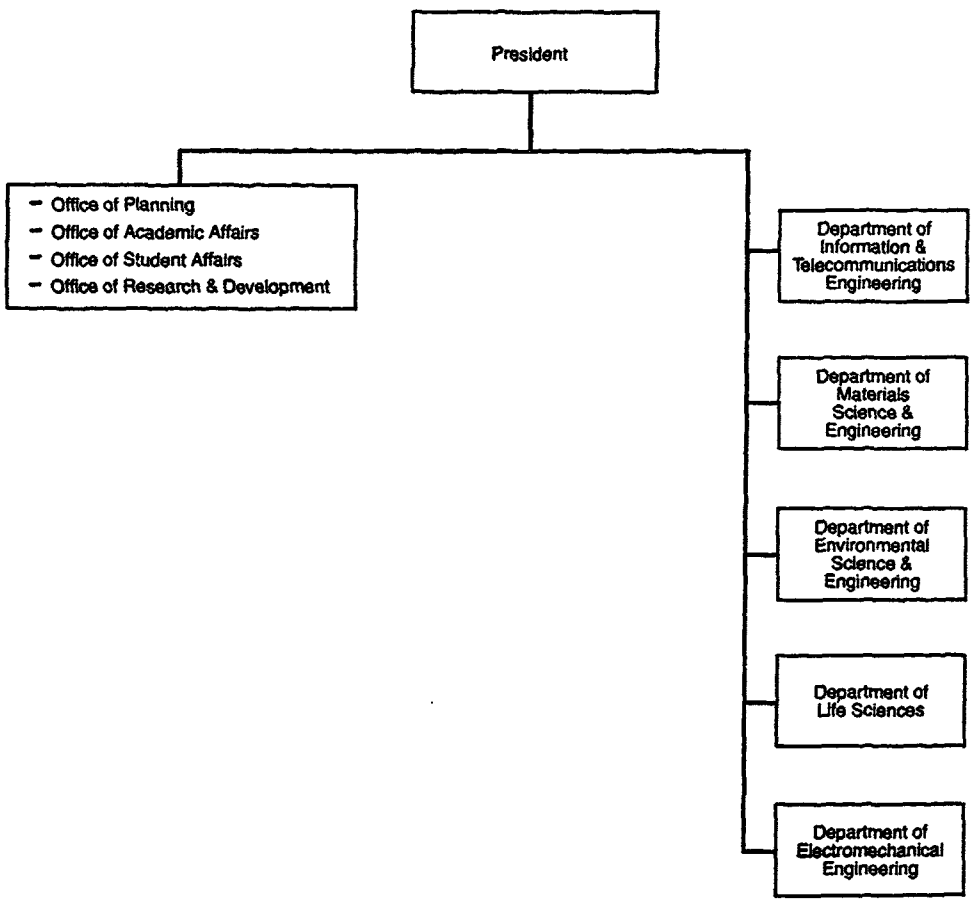
KOREA
ENVIRONMENTAL TECHNOLOGY DEVELOPMENT PROJECT
Systems Engineering Research Institute
Organization Chart



KOREA
ENVIRONMENTAL TECHNOLOGY DEVELOPMENT PROJECT
Korea Advanced Institute of Science and Technology, Kwangju
Organization Chart



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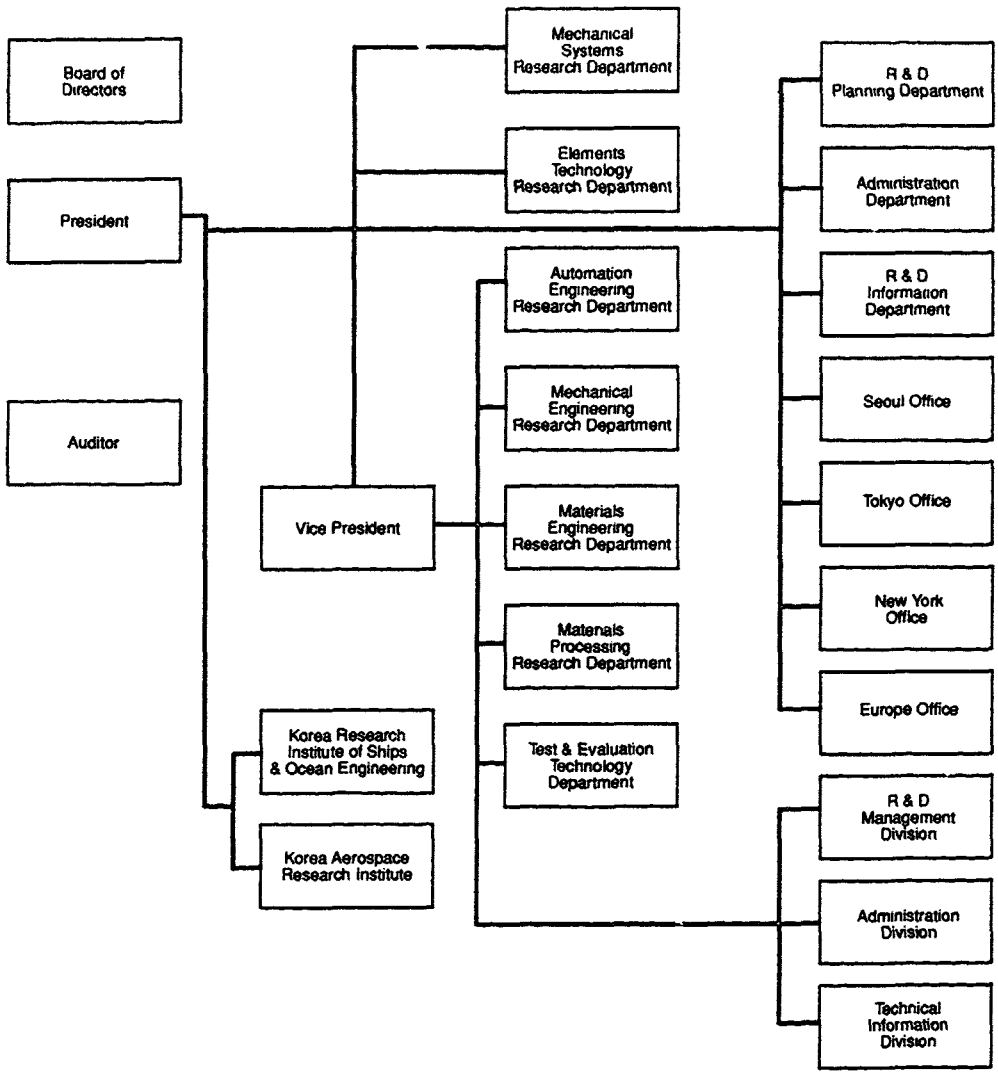
KOREA
ENVIRONMENTAL TECHNOLOGY DEVELOPMENT PROJECT
Korea Institute of Machinery and Metals
Organization Chart



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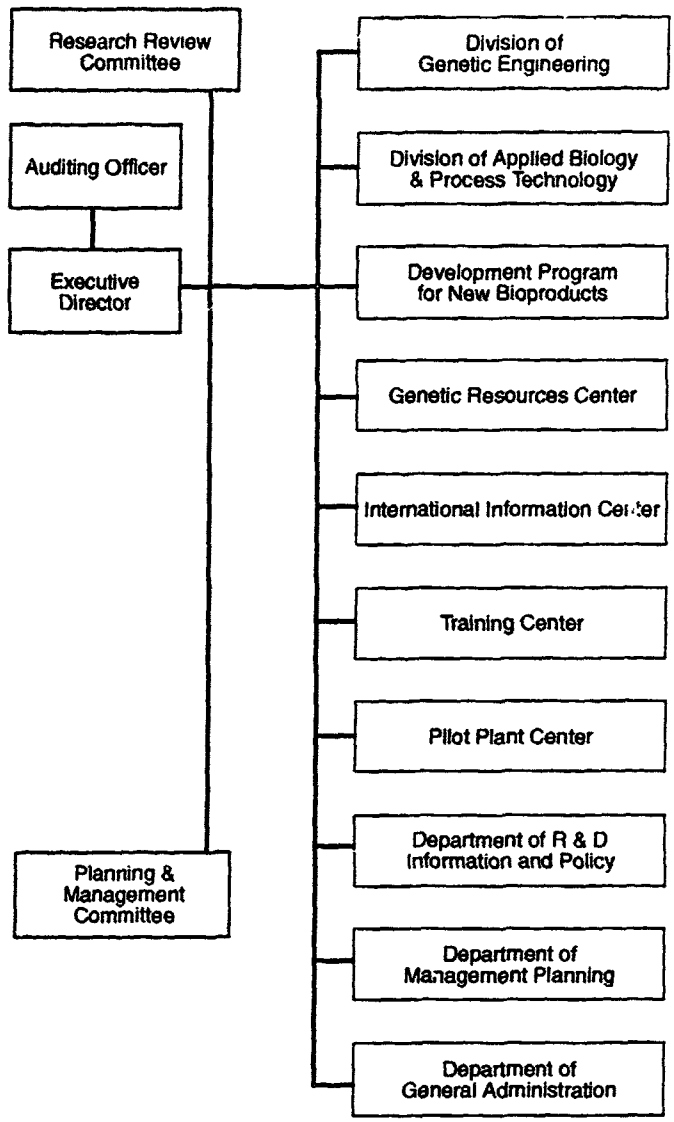
KOREA
ENVIRONMENTAL TECHNOLOGY DEVELOPMENT PROJECT
Genetic Engineering Research Institute
Organization Chart



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KOREA

ENVIRONMENTAL TECHNOLOGY DEVELOPMENT PROJECT

Detailed Project Costs by Component and Category
(Won Billion)

	Equipment	Equipment Transportation and Installation	O&M	Consumable Materials	Technical Assistance and Library Materials	Civil Works	Total Cost WonB	Total Cost US$M
Ministry of Environment	1.2	0.1	0.2	0.2	0.3	-	2.0	2.6
Korea Advanced Institute of Science and Technology	15.2	0.8	1.9	1.8	2.4	-	22.1	28.4
Korea Academy of Industrial Technology	14.5	0.8	1.8	1.8	0.8	0.6	20.3	26.0
Korea Research Institute of Standards and Science	7.7	0.5	1.0	1.0	-	2.1	12.3	15.6
Korea Ocean Research and Development Institute	6.9	0.4	0.8	0.8	0.9	-	9.8	12.6
Systems Engineering Research Institute	6.9	0.4	0.8	0.9	0.8	-	9.8	12.6
Kwangju Advanced Institute of Science and Technology	4.7	0.3	0.4	0.4	0.8	2.3	8.9	11.4
Korea Institute of Machinery and Metals	3.8	0.2	0.4	0.4	-	5.5	10.3	13.2
Genetic Engineering Research Institute	2.5	0.2	0.3	0.3	1.4	0.8	5.5	7.1
Baseline Cost	63.4	3.7	7.6	7.6	7.4	11.3	101.0	129.5
Contingencies								
Physical	6.3	0.4	0.8	0.8	0.7	1.1	10.1	12.9
Price increase	5.5	0.5	1.5	1.5	0.6	1.1	10.7	13.6
Subtotal Contingencies	11.8	0.9	2.3	2.3	1.3	2.2	20.8	26.5
Total Project Cost								
Won billion	75.2	4.6	9.9	9.9	8.7	13.5	121.8	
US$ million	95.9	6.0	12.6	12.6	11.7	17.2		156.0

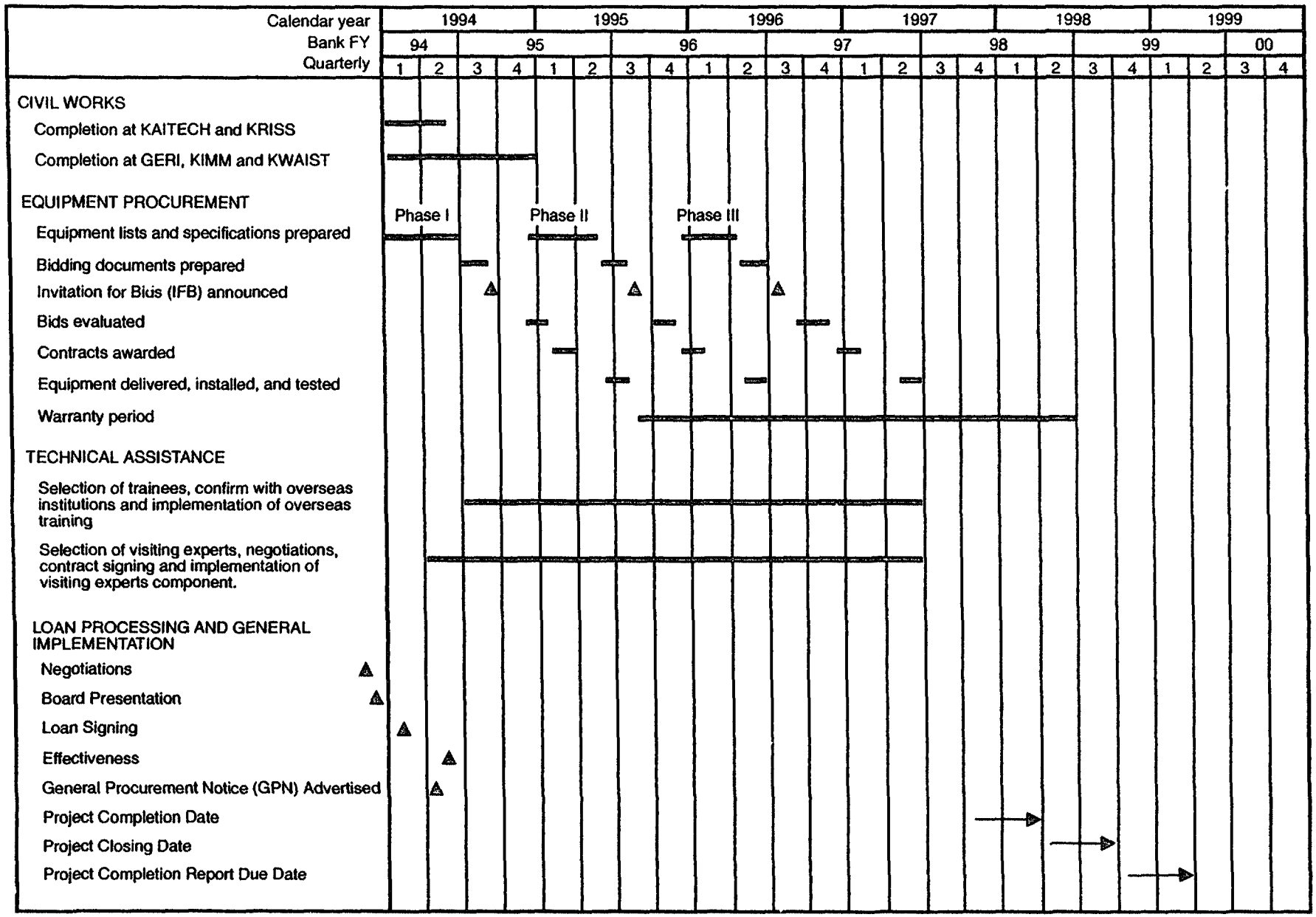
KOREA

ENVIRONMENTAL TECHNOLOGY DEVELOPMENT PROJECT

Project Expenditure by Year and Recipient

	Base Costs (Won Billion)					Total Cost	
	93/4	94/5	95/6	96/7	97/8	Won B	US$M
Ministry of Environment	1.5	0.3	0.1	0.1	2.0	2.6	
Korea Advanced Institute of Science and Technology	0.9	6.1	8.2	4.6	2.3	22.1	28.4
Korea Academy of Industrial Technology	0.9	5.8	6.5	5.1	2.0	20.3	26.0
Korea Research Institute of Standards and Science	0.5	4.9	4.5	1.4	1.0	12.3	15.6
Korea Ocean Research and Development Institute	0.5	2.3	4.0	2.0	1.0	9.8	12.6
Systems Engineering Research Institute	0.5	2.3	4.2	1.8	1.0	9.8	12.6
Kwangju Advanced Institute of Science and Technology	-	3.1	1.6	3.4	0.8	8.9	11.4
Korea Institute of Machinery and Metals	-	3.5	4.6	1.5	0.7	10.3	13.2
Genetic Engineering Research Institute	-	1.8	3.0	0.5	0.2	5.5	7.1
Baseline Cost	3.3	31.3	36.9	20.4	9.1	101.0	129.5
Contingencies							
Physical	0.3	3.2	3.7	2.0	0.9	10.1	12.9
Price increase	0.1	2.0	3.7	2.9	2.0	10.7	13.6
Total Project Cost	3.7	36.6	44.4	24.7	12.0	121.8	156.0
Foreign Exchange	3.1	25.5	35.2	18.8	5.4	88.0	112.9

KOREA
ENVIRONMENTAL TECHNOLOGY DEVELOPMENT PROJECT
Implementation Schedule



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Annex 13

KOREA

ENVIRONMENTAL TECHNOLOGY DEVELOPMENT PROJECT

SUPERVISION PLAN

Approximate Dates (Month/Year)	Activity	Expected Skill Requirements	Staff Input (Staff-weeks)
9/94	Supervision Mission Review final equipment lists and specifications for Phase I procurement	Project management Procurement	1.0 1.0
3/95	Supervision Mission Review semi-annual progress report* Review sample of bid evaluation reports Review SOE documentation Review TA program*	Project management Procurement	.0 1.0
9/95	Supervision Mission Review final equipment lists and specifications for Phase II procurement Review progress report Review sample of bid evaluation reports and SOE documentation Review TA program	Project management Environmental technology Procurement	2.0 2.0 1.0
3/96	Supervision Mission Review progress report Visit selected laboratories to review equipment utilization. Review sample of bid evaluation reports and SOE documentation Review TA program *The regular review of the progress reports and TA program would include special attention to the overall contribution of visiting experts, overseas training and equipment supply to the expansion and improvement of environmental research activities.	Project management Environmental technology Procurement	1.0 1.0 1.0

KOREA

ENVIRONMENTAL TECHNOLOGY DEVELOPMENT PROJECT

SUPERVISION PLAN

Approximate Dates (Month/Year)	Activity	Expected Skill Requirements	Staff Input (Staff-weeks)
9/96	Supervision Mission Review progress report Review final equipment lists and specifications for Phase III procurement Review sample of bid evaluation reports and SOE documentation Review TA program	Project management Procurement	2.0 1.0
3/97	Supervision Mission Review progress report Review sample of bid evaluation reports and SOE documentation Visit selected laboratories to review equipment utilization Review TA program	Project management Environmental technology Procurement	2.0 1.0 1.0
9/97	Supervision Mission Review progress report Review sample of bid evaluation reports and SOE documentation Review TA program	Project management Procurement	2.0 1.0
3/98	Supervision Mission Review progress report Review sample of bid evaluation reports and SOE documentation Visit selected laboratories to review equipment utilization	Project management Environmental technology Procurement	2.0 1.0 1.0
9/98	Supervision Mission Prepare for PCR	Project management	2.0
1/99	Completion Mission Prepare PCR	Project management Environmental technology Procurement	2.0 2.0 1.0

KOREA

ENVIRONMENTAL TECHNOLOGY DEVELOPMENT PROJECT

Disbursements

IBRD Fiscal Year and Semester	Disbursements			Disbursements Profile a/ (%)
	Semester	Cumulative	as % of Total	
	----------US$----------			
1994				
1	-	-	-	-
2	9.0 b/	9.0	10	3
1995				
1	2.0	11.0	12	6
2	15.0	26.0	29	18
1996				
1	18.0	44.0	49	38
2	16.0	60.0	67	54
1997				
1	12.0	72.0	80	70
2	10.0	82.0	91	86
1998				
1	7.0	89.0	99	94
2	1.0	90.0	100	96
1999				
1	-	-	-	98
2	-	-	-	100

a/ Standard disbursement profile for education projects in Korea.
b/ Initial deposit in Special Account.

KOREA

ENVIRONMENTAL TECHNOLOGY DEVELOPMENT PROJECT

Selected Documents Available in the Project File

A. Reports and Studies Related to the Sector/Subsector

* A-1 Environmental Protection in Korea, Ministry of Environment, Republic of Korea, 1990.

* A-2 National Report of the Republic of Korea to UNCED 1992, Ministry of Environment, Republic of Korea, December 1991.

* A-3 Environmental Education in Asian Countries, AST/IBRD, April 1991.

A-4 Status and Activities of Technology Development in Korea, KIRI, 1989.

A-5 International Trend of Environmental Technology Development, undated.

B. Reports and Studies Related to the Project

** B-1 Research Capability Reinforcement for Global Environmental Protection, October 1992.

** B-2 Ditto, December 1992.

B-3 Proposal for IBRD Loan Project in Korea Towards 21st Century, February 1992.

B-4 KETRI, IBRD Loan Project Proposal, March 1993.

B-5 GERI, Visiting Experts TOR, undated.

B-6 SERI, TOR for List of Experts, undated.

B-7 Reply to IBRD Information Requirements, March 1993

B-8 KAIST, Equipment Lists, Experts, Library Materials, June 1993

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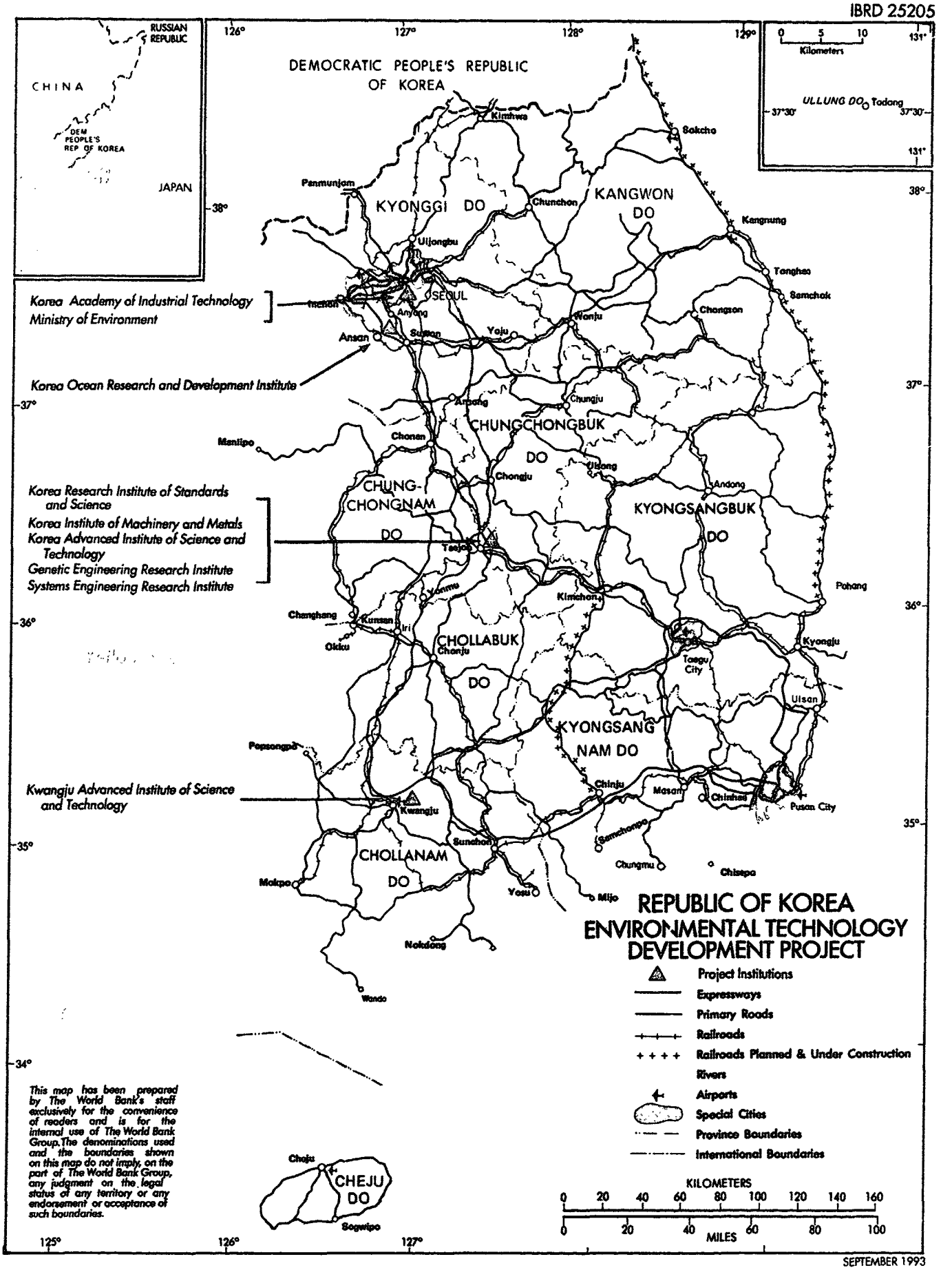
* See Project File for the Environmental Research and Education Project (Loan 3612-KO)

** Includes equipment lists and schedules of overseas training and visiting experts

MAP SECTION

IBRD 25205



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SEPTEMBER 1993